PRE-CONSTRUCTION ACOUSTIC MONITORING

Mount Wachusett Community College Wind Project

Worcester County, Massachusetts

Prepared for:

Mount Wachusett Community College
444 Green Street
Gardner, MA 01440

Prepared by:

D. Scott Reynolds, Ph.D.
North East Ecological Services
52 Grandview Road
Bow, NH 03304

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Mt. Wachusett Community College Wind Project

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Pre-Construction Acoustic Monitoring

Mt. Wachusett Community College Wind Project

EXECUTIVE SUMMARY

The Mount Wachusett Community College ("MWCC") Wind Project proposal is for the construction and operation of a 1-2 turbine wind project on the Mount Wachusett Community College campus in Gardner (Worcester County), Massachusetts. As part of the environmental assessment of this proposal, North East Ecological Services (NEES) was contracted to conduct pre-construction acoustic monitoring to determine the potential impact of project construction and operation on bats.

Based on data collected through acoustic monitoring, NEES makes the following conclusions:

1) Roost surveys of Worcester County and bat activity data at the project site suggests a significant resident bat population in the area that is dominated by the big brown bats and little brown myotis.

2) 80% of the total bat activity was detected at the LOW microphone, well below the rotor sweep zone of the turbine. Less than 1% of the total bat activity was heard at the HIGH microphone within the rotor sweep zone of the turbine.

3) Overall levels of bat activity were similar to other pre-construction acoustic monitoring surveys

4) *Myotis spp.* represented 30.6% of the total bat activity. Over 90% of the bat activity from *Myotis spp.* occurred at the LOW microphone and none occurred at the HIGH microphone within the rotor sweep zone of the proposed wind turbine. The *Myotis spp.* group contains four species including the federally-endangered Indiana myotis, *M. sodalis* and the state Species of Special Concern eastern small-footed myotis, *M. leibii*.

5) Bats within the *Myotis spp.* group cannot be reliably identified using acoustic signatures. Given the lack of documented *M. leibii* and *M. sodalis* within 50 km of the project site and the proximity of the MWCC project site to suburban landscapes, it is likely that most, if not all of the *Myotis spp.* activity can be attributed to the little brown myotis, *M. lucifugus*.

6) Acoustic monitoring of Patterns of bat activity (evening temporal data, altitudinal variation, and species composition) are more consistent with summer foraging and commuting activity than migratory activity.

7) Acoustic monitoring of migratory bats suggests that all species of tree bats (red bat, hoary bat, and silver-haired bat) were detected at the project site.

8) Hoary bats, the most commonly killed bat at wind development sites, represented almost 11% of the total bat activity; this is a lower percentage of total activity than seen at many pre-construction acoustic monitoring surveys.

9) The MWCC data, compared to other pre-construction wind projects, suggest medium levels of bat activity throughout both the summer sampling period and fall migratory sampling period.

10) NEES recommends that additional monitoring be carried out during the spring migratory season (15 March – 14 June) to document an entire active season for bats near the project site.

11) Based on these data, NEES concludes that fatality numbers at the project site are likely to be similar in composition but lower in magnitude (on a per turbine basis) to other wind projects sites in the northeastern United States. Given the size of the project, it is unlikely to have a significant impact on bat populations in the region.

1.0 PROJECT OVERVIEW

1.1 The MWCC Wind Project

The MWCC Wind Project proposal is for the construction and operation of one or two 1.5 MW wind turbines (estimated 1.5 to 3.0 MW total capacity) on the MWCC campus located in northern Worcester County, Massachusetts (Fig. 1). The project layout encompasses approximately 4.5 ha. The project consists of a single parcel of publicly owned land, located within the City of Gardner, approximately 1.5 km south/southeast of the intersection of SR-140 and Green Street.

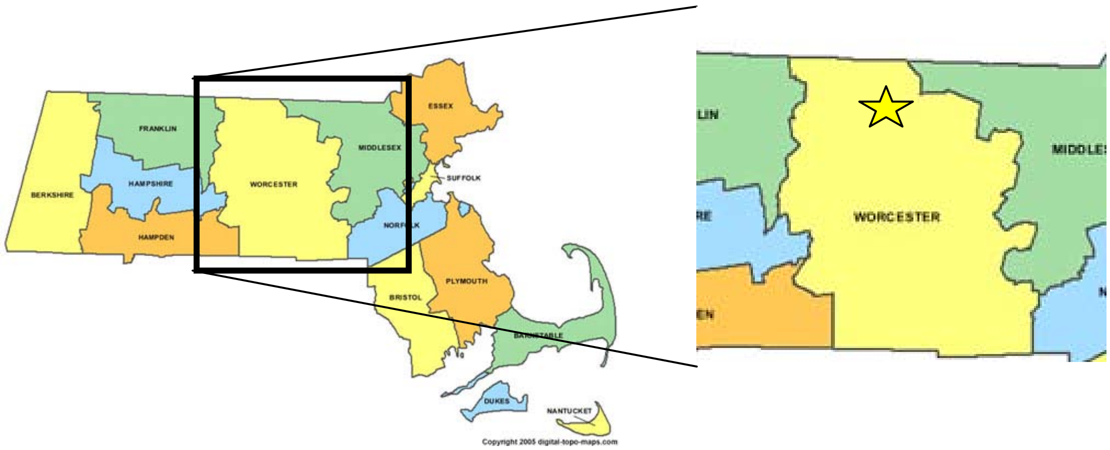

Figure 1: General location of the MWCC Wind Project in Massachusetts

2.0 PRE-CONSTRUCTION ACOUSTIC SURVEY

Most bat mortality appears to occur during migration. Consequently, an understanding of the baseline migratory activity at the MWCC project site during the fall migratory period is critical in understanding the potential impact of this project on bats. Data collected from these efforts will help inform biologists and managers about the scale of geographic, altitudinal, and temporal variation in bat activity across the project areas. This, in turn, should help identify the potential impact of wind turbine development and provide quantitative data for BACI (Before-After Control Impact) comparison following construction of the project. These studies have been completed for the summer breeding season and the fall migratory season using a protocol that is consistent with the recommendations of the National Research Council (NRC, 2007) guidelines.

2.1 Equipment Calibration and Data Collection

Data were collected using Anabat™ SD-1 ultrasonic detection systems placed at various heights on an existing meteorological ('Met') tower (Figure 2). Microphones were placed on the Met tower using a pulley system that allowed the microphones to be adjusted, replaced, or relocated without lowering the met tower. The microphones were housed in a weather-tight PVC housing and oriented towards the ground to prevent moisture from collecting on the transducer. A 10 cm^2 square Lexan sheet was mounted below the microphone at 45 degrees from horizontal to deflect sound up towards the microphone. Due to the length of the cables, we used Titley™ HI-MIC pre-amplified microphones. The microphones were attached to the Anabat ultrasonic detector using customized cables (EME Systems, Berkeley, California) based on a Canare Starquad™ video cable with an additional preamplifier soldered into the terminal end of the cable to increase signal strength.

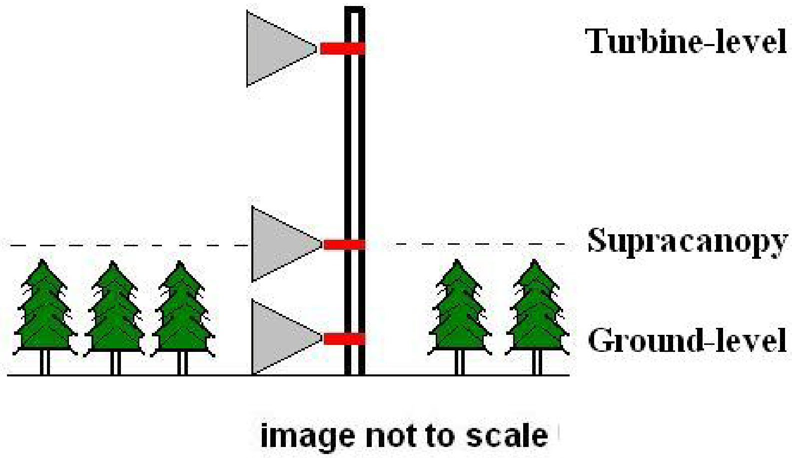

Figure 2. Schematic of Meteorological Tower microphone array

The Anabat™ SD-1 interface module stores bat echolocation signals on removable CF-flash cards. The detectors were placed in a NEMA-4 weatherproof enclosure mounted to the base of the Met tower and powered by a 30W photovoltaic charging system. All microphones and cables were calibrated (before installation and after de-construction) in a test facility using a Binary Acoustics AT-100 multifrequency tonal emitter (BAT, Las Vegas, Nevada) to confirm minimum performance standards for six different ultrasonic frequencies (20kHz, 30kHz, 40kHz, 50kHz, 60kHz, and 70kHz). In addition, a minimum cone of receptivity (15° off-center) was verified by rotating the microphone horizontally on a platform using the AT-100 as a sound source.

The Anabat monitoring systems were programmed to monitor for ultrasonic sound from 18:00 – 08:00 each night throughout the sampling period (05 June – 11 November, 2008). Data cards were retrieved by MWCC personnel (Robert Rizzo) at approximately weekly intervals. At each visit to the Met tower site, the data cards were removed from each recording system and replaced with new cards. All card removals and replacements were documented on field sheets provided and stored in each tower enclosure. Data cards were mailed to NEES in protective envelopes for analysis.

2.2 Data Analysis Protocol

Data were analyzed using the Analook™ 4.9j graphics software. Bat echolocation recordings were separated from non-bat sounds based on differences in time-frequency representation of the data (Table 1). Files that were determined to be of bat origin were analyzed semi-quantitatively using a dichotomous key that distinguishes species based on a variety of call features. Species identification was conservative to minimize identification error and maximize total number of calls included in the analysis. Specifically, high variation in calls within the genus *Myotis* precludes reliable species identification (Murray et al., 2001). We grouped silver-haired bats (*Lasionycteris* *noctivagans*) and big brown bats (*Eptesicus fuscus*) into a single group (Lnoct-Efus) to reduce errors in identification of these two species. For those calls that were not of a high enough quality to extract diagnostic features, an "Other Bat" category was used to document total bat activity.

Table 1. Descriptive breakdown of acoustic file source origins

Category	**General Description of Time-Frequency Analysis of Data**	**Probable Source(s)**
Wind Noise	random pixilation with little to no pattern	wind
Mechanical	Long calls (> 100 ms) with high constant-frequency (CF) component and drifting characteristic frequency (Fc)	cable resonance EM interference
Biological (non-bat)	Frequency-modulated (FM) call structure with ascending pitch or with characteristic frequency in audible range	insects birds, flying squirrels
Bat Activity	FM or CF dominated data file with species-specific call durations, pitch changes, or other attributes	bats

2.3 Data Assumptions and Presentation Format

The following data were collected in order to characterize the bat activity that occurs at the Project site. Several assumptions were made in order to characterize this activity:

a) bat activity recorded at the Met tower adequately represents bat activity across the Project site.
b) the microphones are properly oriented to record echolocation calls of bats as they fly across the Project site
c) there is relatively little bat activity during the daytime (0800 – 1800)
d) the sampling period (05 June through 11 November) accurately represents the seasonal activity period of bats at the Project site
e) the echolocation calls recorded on unique data files are independent and do not represent the same individual over multiple sampling periods
f) echolocation calls within the same data file can be treated as a set of calls from a single individual

Assumption a) is based on the technological and methodological constraints that exist at a wind development project. Prior to the concern about turbine-related bat mortality, there were only a few studies that attempted to acoustically document bat migratory activity (for example, Zinn and Baker, 1979; Barclay, 1984). Even fewer studies attempted to document bat activity at altitudes above the tree canopy (for example, Davis et al., 1962; McCracken, 1996). This lack of emphasis was due to the difficulty of recording ultrasonic sound over large periods of time (limitations of recording equipment), wide areas of space (high signal attenuation of ultrasonic wavelengths), or at high altitude. Although most project sites contain appropriate sampling platforms to collect these data (meteorological towers), they are generally non-mobile and often spatially limited across the Project site. However, they are generally sited where turbines will ultimately be constructed and therefore may adequately represent the relevant air space that is available for migratory bats at the project site. Assumption b) is a technical limitation of the condenser microphones used by the ultrasonic recording equipment.

Assumption c) has been validated by numerous field studies and therefore is strongly supported by existing data. Assumption d) is not valid because bats are known to be active well before early June. Conducting additional monitoring during the spring (15 March – 14 June) will validate this assumption. Assumptions e) and f) relate to how bat calls are recorded and represented. Although there is a wide range of opinion on how to interpret echolocation calls, there is a general agreement that researchers should not use echolocation call files as a measure of species abundance unless those calls are independent. This requires that data are collected and analyzed to ensure the spatial- and temporal-independence of each recording. Spatial independence is created by placing microphones in non-overlapping sampling environments. Temporal independence can be created by making assumptions about the time individual bats will remain within the sampling space. Because we do not have adequate research on migratory activity, we cannot make well-grounded assumptions about temporal independence of individual calls. For example, two bat calls recorded at the LOW microphone within ten seconds may represent a single bat flying near the microphone. However, two calls recorded 60 minutes apart are unlikely to represent the same bat. To avoid this potential non-independence, this report will focus on total bat activity, not species abundance or species eveness (relative abundance of each species).

Table 2. Summary of terms and definitions used to describe bat activity

bat activity	Activity estimate calculated from the total number of echolocation calls recorded
high risk species	bats species known to collide with wind turbines at rates higher than predicted based on their abundance during capture (e.g. mist netting) sampling
calls/detector-hour (calls/dh)	Standardized measure of bat activity (controlling for variation in total sampling effort at each site)
peak 7-day activity	estimate of peak sustained migratory activity
fall migration	bat activity from 16 August through 10 November
spring migration	bat activity from 15 March through 31 May
summer activity	bat activity from 01 June through 15 August

2.4 Acoustic Monitoring Station

The MWCC project site had a pre-existing temporary Met tower at the project site. The Met Tower was located within an approximately 4.5 ha old field, with very few invading trees. The old field was bordered by a second growth forest to the east, which extended to both the east and northeast. A relatively long (at least 100 m), narrow (~ 2 m width) area of rock jumble was observed along the east edge of the project field, and approximately 3 to 6 m into the forest interior. This area of rocks was composed of medium and large size boulders, which likely constituted a historical stone wall. The boulders occurred mainly at ground level, and since the rocks were shaded by overstory trees, received only intermittent exposure to the sun. A small (0.75 ha) open water pond borders the project field to the west. Additional wetlands occur to the east of the project field, including a small red maple swamp located approximately 150 m east/northeast of the project field. Several large pond and lakes were observed, including Crystal Lake and Perley Brook Reservoir to the west, Lake Wampanoag, Mamjohn Pond, and Hobby's Pond to the northeast, and Dunn Pond to the southeast. Several additional small ponds were observed both on the MWCC campus property and within the adjacent golf course to the west. Additional details about the site are provided in the Phase I Bat Risk Assessment (NEES, 2008).

The acoustic monitoring system was installed on the Met Tower on 05 June, 2008. All microphones were mounted facing north (azimuth of 0°) to face the direction of probable fall migration. Although the Massachusetts Division of Fisheries and Wildlife does not prescribe sampling conditions, north-facing microphones are recommended in New York State (NYDEC, 2007). The low microphone (LOW) was installed at 10 m altitude, the middle microphone (MID) was installed at 30 m altitude, and the high microphone (HIGH) was installed at 60 m altitude.

3.0 ACOUSTIC MIGRATORY SURVEY RESULTS

3.1 Sampling Effort

Bat activity was monitored from 05 June through 11 November, 2008. The total sampling period in 2008 was 161 days, or 2,254 hours per detector. Due to the potential for data overload, failure to swap cards, card reading failures, or equipment malfunction, the actual sampling effort of each microphone is generally less than this maximal potential sampling effort. The sampling effort at the MWCC project site is summarized in Table 3.

Table 3. Acoustic Sampling Effort at the MWCC Wind Project Site

Microphone	Total Days Monitoring	Percent of Total Monitoring	Reasons for Data Loss (days of loss)
LOW	133	82.6%	failure to swap cards (6) card failure (22)
MID	149	92.5%	failure to swap cards (12)
HIGH	122	75.8%	failure to swap cards (12) card overload (9) card failure (18)
AVERAGE	**133.3**	**83.6%**	

3.2 Overall Data

A total of 218,391 files was recorded by the acoustic monitoring equipment. After analysis, 2,150 files (1.0%) were determined to be of bat origin. Although the vast majority of the acoustical activity was wind noise, there were some files that appeared to be mechanical and non-bat biological in origin. Combining data from all microphones, bat activity was documented on 118 of the sampling days (76.1%); 78.4% of the nonactivity days occurred during the final five weeks (29 of 37 days). Mean daily bat activity was 13.4 calls per night.

A depiction of overall bat activity at each tower is shown in Figure 3. Each pie graph is scaled to represent total relative activity (with actual bat calls identified by the numbers next to each graph).

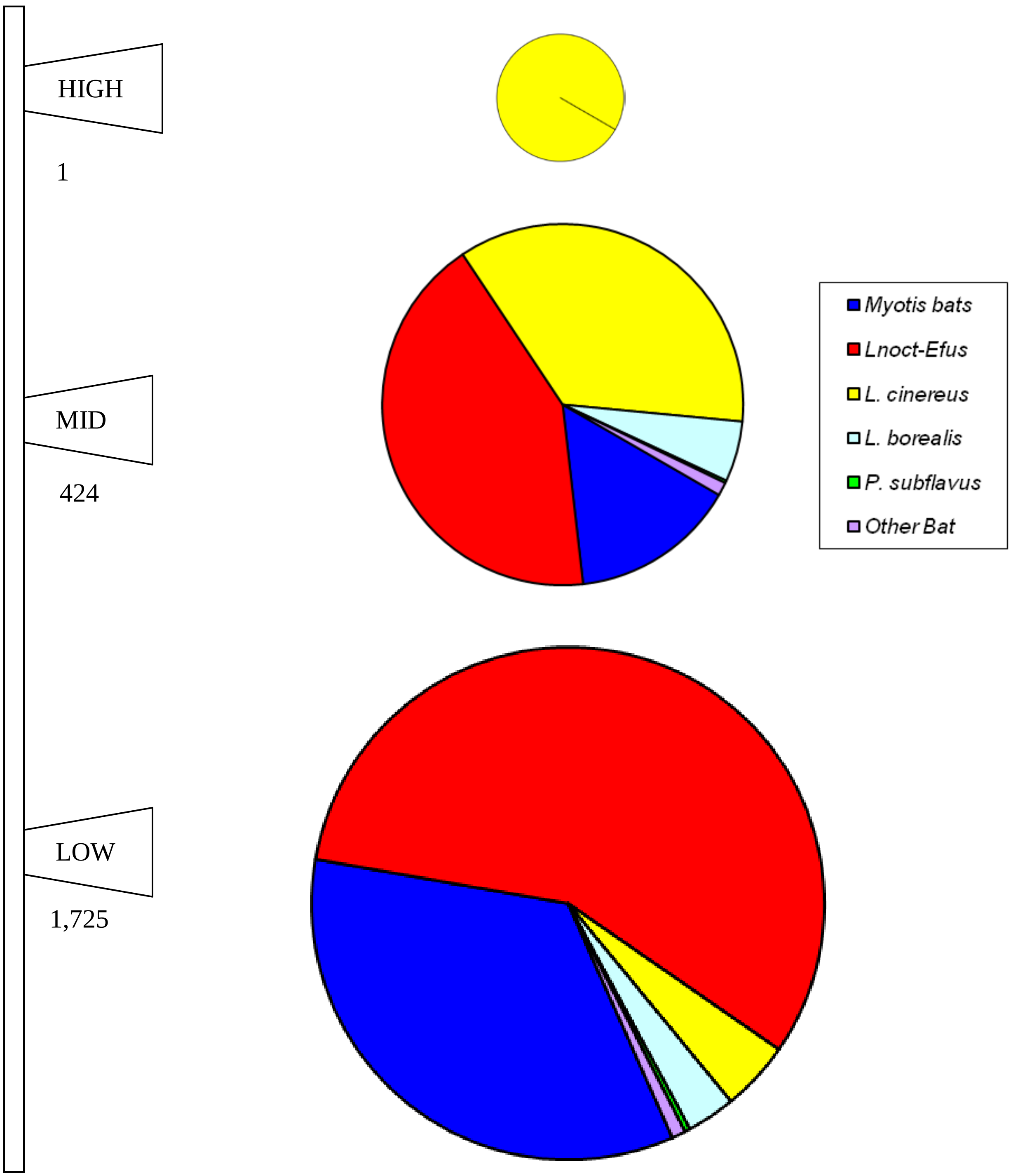

Figure 3: Distribution of Bat Calls across Microphone Heights by Species

3.3 MWCC Met Tower

3.3.1 Low Microphone

During the period from 05 June through 11 November, 2008, a total of 5,690 files were recorded and analyzed. It was determined that 1,725 files were of bat origin. A minimum of five species or species groups were detected at the LOW microphone. The silver-haired/big brown group (*Lnoct-Efus*) and the *Myotis* spp. group (*Myotis* bats) were the dominant bats heard at the LOW microphone, comprising 56.9% and 34.4% of all calls, respectively (Figure 4).

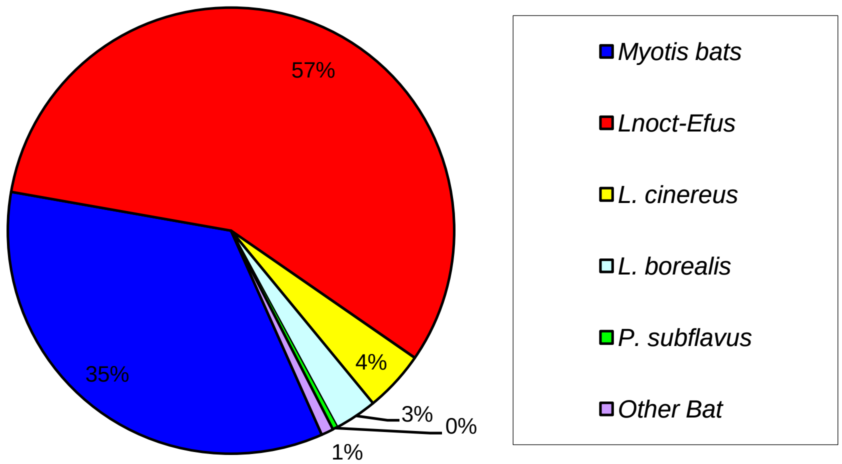

Figure 4: Distribution of Bat Calls at the MWCC Tower LOW Microphone

Looking across the entire sampling period, one gradual activity peak was recorded at the LOW microphone; this peak occurred during the seven-day period beginning 01 September (Figure 5). No bat activity was heard after 01 November.

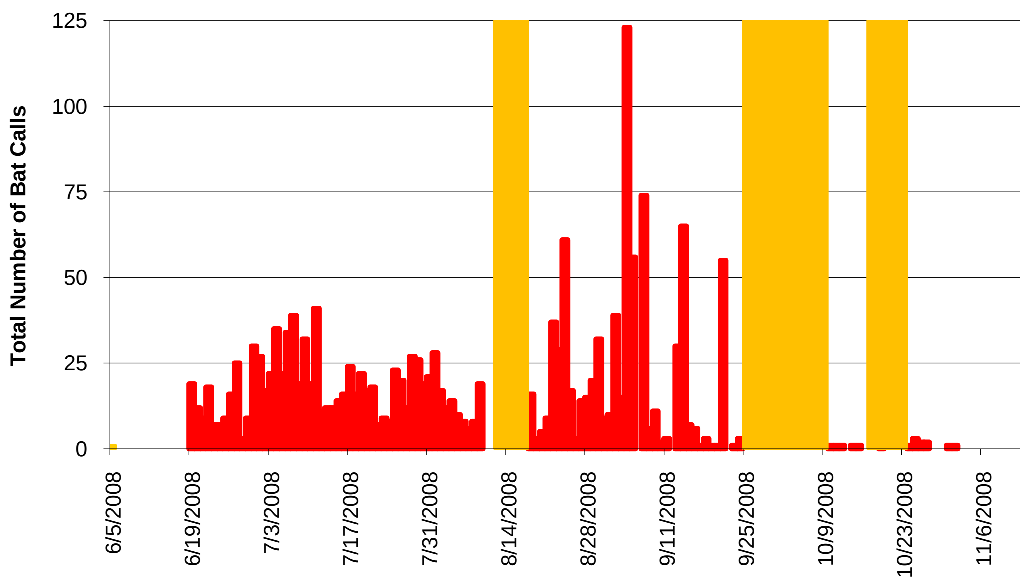

Figure 5: Seasonal Distribution of Bat Calls at the MWCC Tower LOW Microphone (yellow bars are periods of no data)

3.3.2 MID Microphone

During the period from 05 June through 11 November, 2008, a total of 141,887 files were recorded and analyzed. It was determined that 424 files were of bat origin. A minimum of five species or species groups were detected at the MID microphone. The silver-haired/big brown bat group (*Lnoct-Efus*) and the hoary bat (*L. cinereus*) were the dominant groups heard at the MID microphone, comprising 42.5% and 35.8% of all calls, respectively (Figure 6).

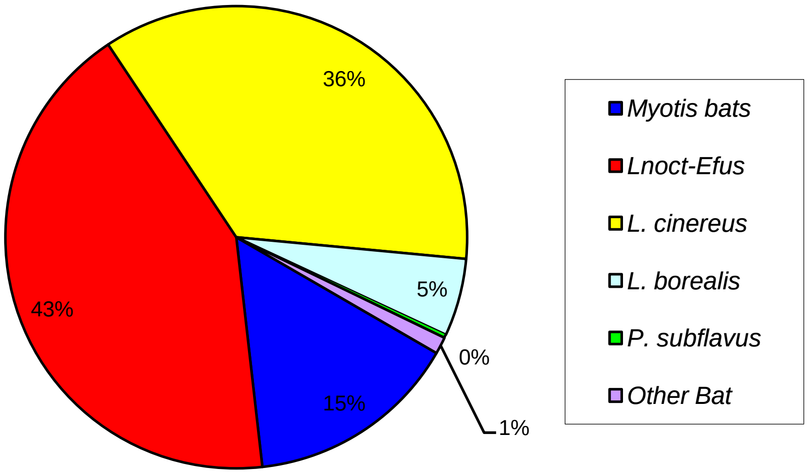

Figure 6: Distribution of Bat Calls at the MWCC Tower MID Microphone

Looking across the entire sampling period, two small activity peaks were recorded at the MID microphone; the first peak was in late June and the second peak occurred during the seven-day period beginning 24 August (Figure 7). With the exception of three calls detected on 27 October, no bat activity was recorded after 12 October.

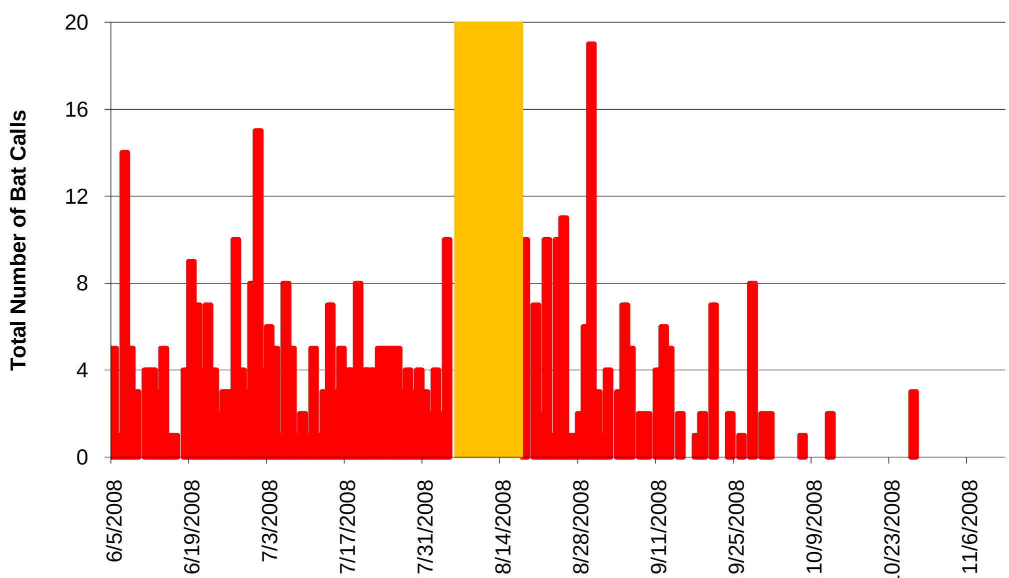

Figure 7: Seasonal Distribution of Bat Calls at the MWCC Tower MID Microphone (yellow bars are periods of no data)

3.3.3 High Microphone

During the period from 05June through 12 November, 2008, a total of 70,814 files were recorded and analyzed. It was determined that only one file was of bat origin. This was a single hoary bat (*L. cinereus*) call detected on 20 July (Figure 8).

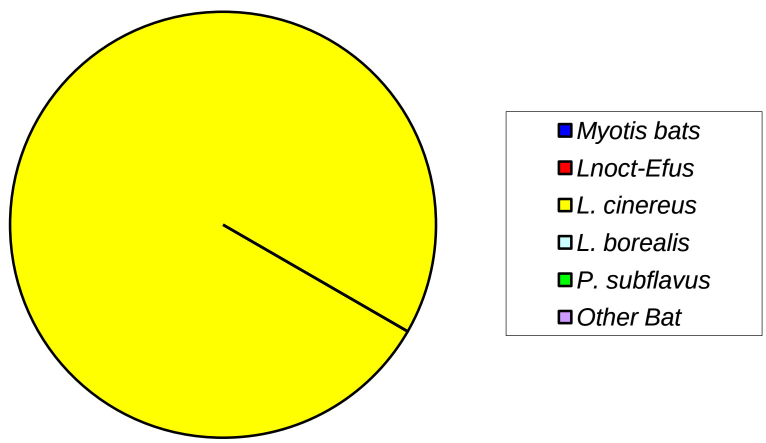

Figure 8: Distribution of Bat Calls at the MWCC Tower HIGH Microphone

The single bat call was heard on 20 July (Figure 9). Due to the lack of activity, no peak periods were evident at the High microphone.

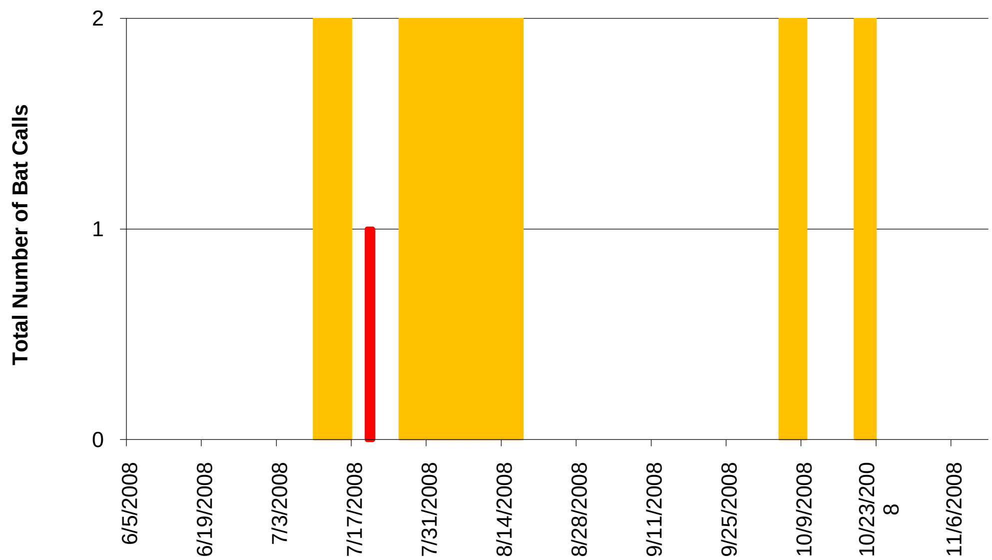

Figure 9: Seasonal Distribution of Bat Calls at the MWCC Tower HIGH Microphone (yellow bars are periods of no data)

3.4 Vertical Distribution of Bat Activity

The highest level of bat activity was observed at the LOW microphone (80.2% of total activity). There was a substantial decline in bat activity with altitude across the project site (Figure 10). When bat activity was standardized by total sampling effort, the LOW microphone had a higher level of activity (13.0 calls/dn) than either the MID microphone (2.8 bats/dn) or HIGH microphone (0.0 bats/dn).

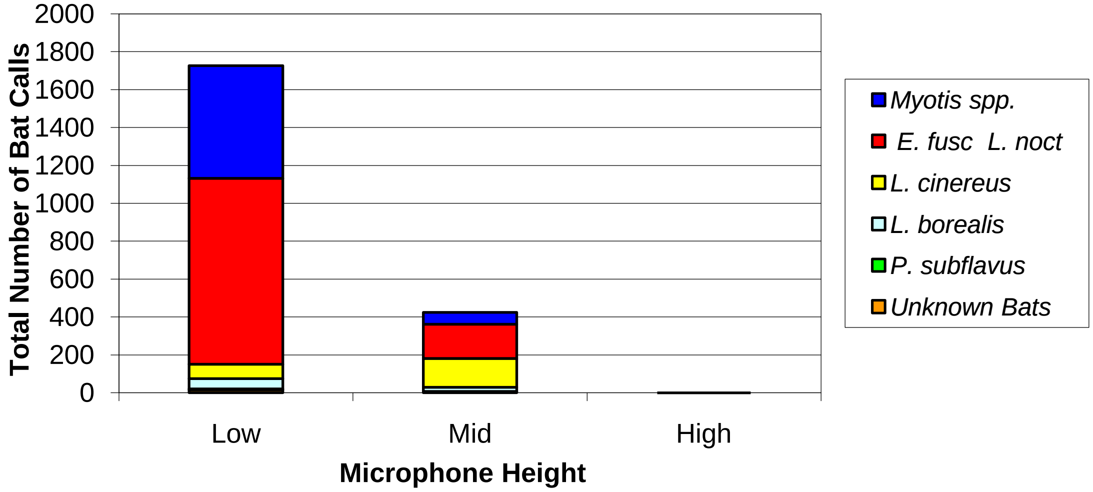

Figure 10: Distribution of Bat Activity Across Microphone Heights by Species

There were also species-group patterns in bat activity. For example, most of the *Myotis* spp. and silver-haired/big brown bat group (*Lnoct-Efus*) calls were recorded at the LOW microphone (Figure 11). Conversely, hoary bats (*L. cinereus*) were most frequently detected at the MID microphone (66.4% of total activity).

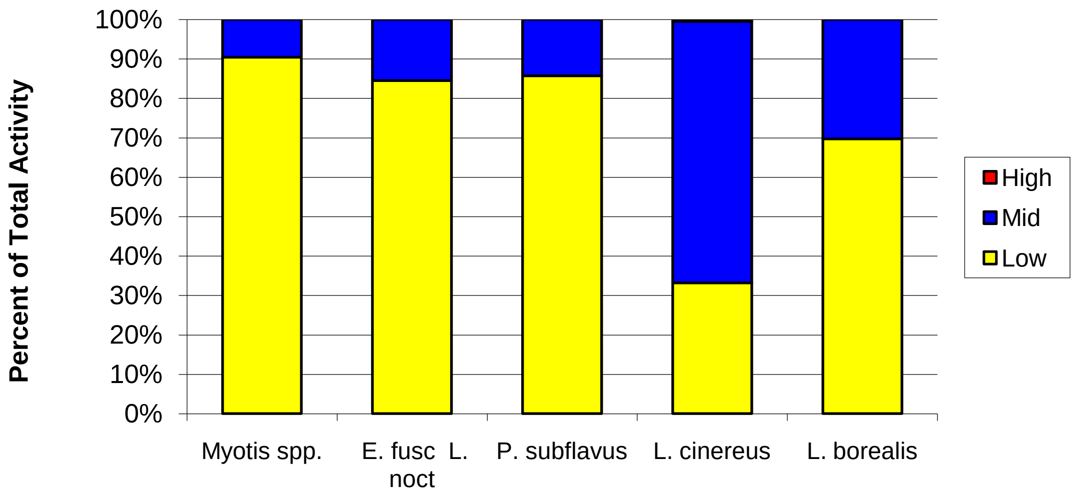

Figure 11: Vertical Distribution of Bat Activity by Species Group

3.5 Temporal Distribution of Bat Activity Across The Year

Pooling all data, there was a general low level of bat activity at the MWCC project site during the monitoring period; however, this was highly influenced by the lack of detectable bat activity at the HIGH microphone. Bats were already active at the project site at the commencement of monitoring, but increased substantially in early July and again in late August before declining to low levels by late September (Figure 12). The general lack of bat activity during the final six weeks of the survey period suggests that we sampled across the entire fall migratory period at the project site. Specifically, these last six weeks represent 26.1% of the entire sampling period, but only 1.0% of the total bat activity. Standardized for sampling effort, the summer period (05 June through 14 August: 7.24 bats/dn) had a similar level of bat activity as the peak fall migratory period (15 August through 30 September: 7.08 bats/dn). These data are consistent with the use of the project site as a summer foraging area for *Myotis* and big brown (*E. fuscus*) bats. However, the presence of bat activity throughout the fall migratory season suggests the project site is also within the migratory corridor of some bats, particularly hoary bats.

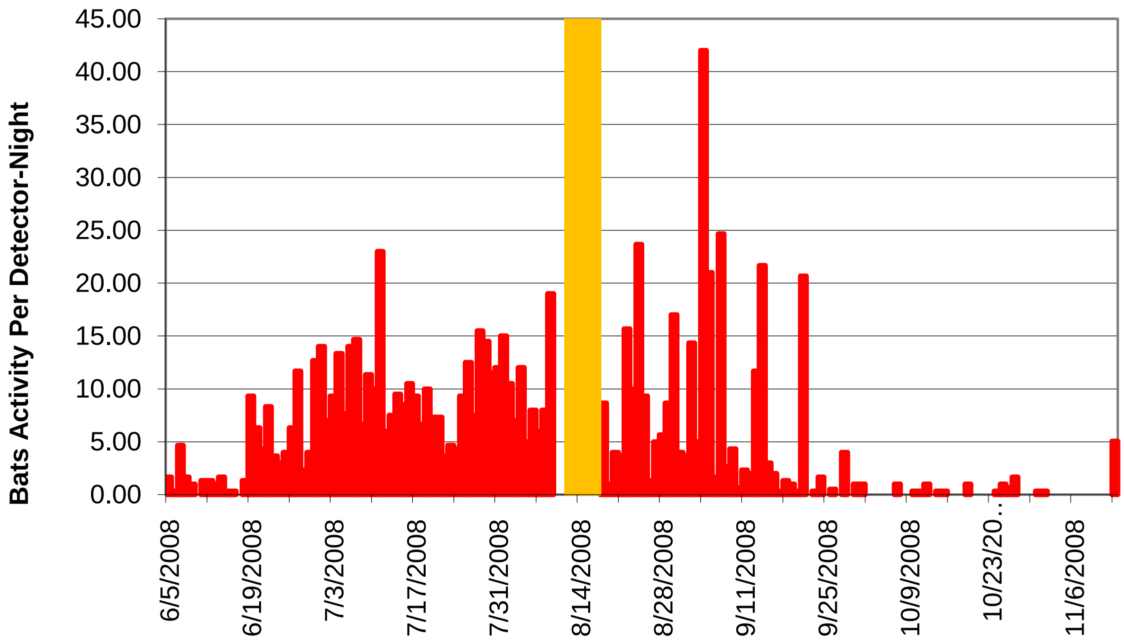

Figure 12: Distribution of Bat Activity Across the Sampling Period

3.6 Temporal Distribution of Bat Activity Across The Night

Data were pooled across the sampling period and analyzed for nightly activity patterns in 15-minute intervals. This showed very little bat activity during the first hour and during the last 120 minutes (0.14% of total bat activity) of the nightly sampling period; only 0.46% of the total bat activity was recorded during the last three hours of sampling. These data strongly suggest that the 14-hour sampling protocol is more than adequate to document bat activity at the project site. Bat activity at the project site was characterized by a rapid increase in activity early in the evening (starting at approximately 19:00) that peaked at approximately 20:00 before declining steadily throughout the evening (Figure 13).

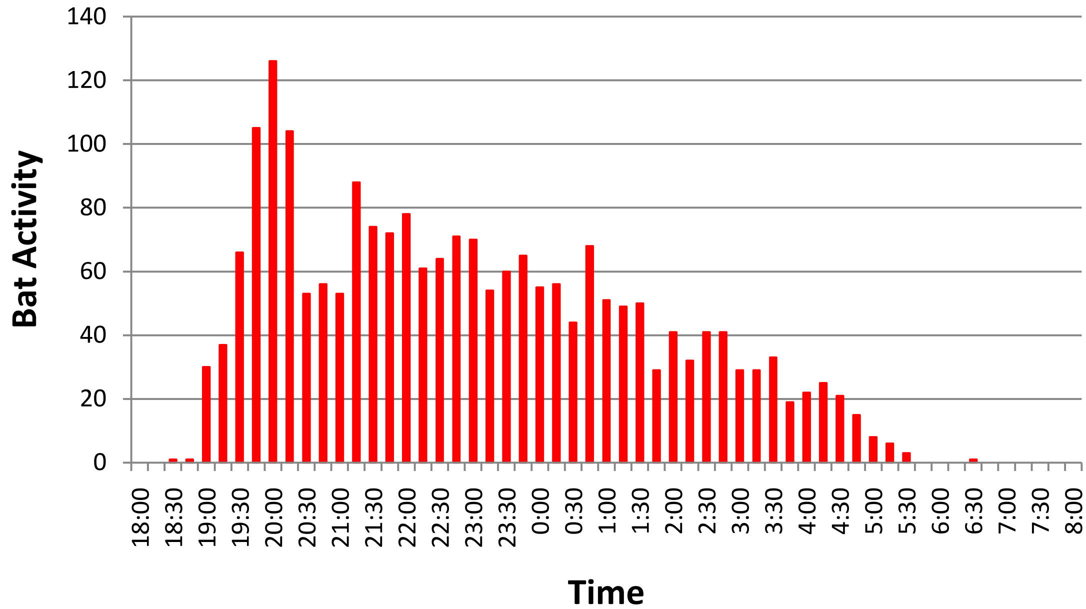

Figure 13: Temporal Distribution of Bat Activity Across the Evening

When the bat activity is analyzed across the vertical sampling array, the data show that the rapid increase in bat activity early in the evening is the result of ground-level bat activity (Figure 14).

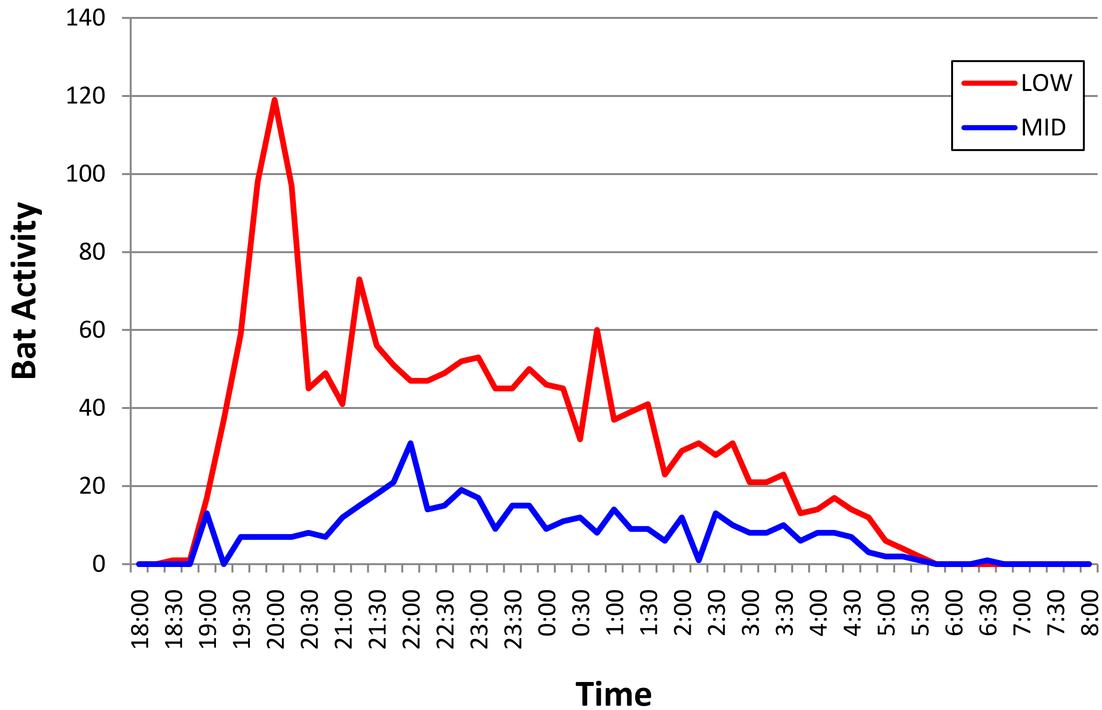

Figure 14: Temporal Distribution of Bat Activity Across LOW and MID Microphones

3.7 Overview of Bat Migratory Acoustic Data

During the 161 days of monitoring at the MWCC project site, a total of 2,150 bat calls was recorded and identified. Analysis of these data suggests the following:

a) wind generated the most data files, with only 1.0% of the data files containing echolocating bats.
b) more calls were heard at the LOW microphone (13.0 calls/detector-night) compared to the MID microphone (2.8 calls/dnh) and the HIGH microphone (0.0 calls/dn).
c) Only one bat (a hoary bat on July 20, 2008) was detected on the HIGH microphone throughout the 122 days of sampling at this height. Microphone calibration before and after use confirm the sensitivity and operation of the detector.
d) across all microphones, the highest percent of activity came from the silver-haired/big brown bat (*Lnoct-Efus*) group (54.0%), followed by the *Myotis spp.* group (30.6%) and the hoary bat (*L. cinereus*: 10.7%).
e) Given the relatively urban landscape surrounding the MWCC project site, it is highly likely that most of the calls from the silver-haired/big brown (*Lnoct-Efus*) species group were from the big brown bat (*E.fuscus*), a house-roosting bat that is well documented within the area and most often found in cities such as Keene and Nashua New Hampshire, as well as Worcester and Leominster, Massachusetts (Reynolds, *pers. obs.*).
f) *Myotis spp.*, which contains five species including the federally-endangered Indiana myotis (*Myotis sodalis*) and the state Species of Special Concern eastern small-footed myotis (*Myotis leibii*), represented 30.6% of the total bat activity. The inability to reliably identify these two species from the other species within the genus *Myotis* limits the use of these data to quantify the potential presence or use of the MWCC project site by these species. However, a bat risk assessment of the project site determined that no *M. sodalis* have been documented during the summer in the state of Massachusetts and there are no documented *M. leibii* within 50 km of the project site. Given the proximity of the MWCC project site to suburban landscapes, it is likely that most, if not all of the *Myotis spp*. can be attributed to the little brown myotis (*M. lucifugus*).
g) Within the *Myotis spp.* group, most of the activity was detected at the LOW microphone (90.4%), well below the rotor sweep zone of the turbines.
h) The hoary bat (*L. cinereus*) was the third most commonly-detected bat during the sampling period, representing 10.7% of all recorded bat activity. The hoary bat was the only bat detected at the HIGH microphone and 66.4% of the activity from the hoary bat was detected at the MID microphone.
i) All species of migratory tree bat, the hoary bat (*Lasiurus cinereus*), red bat (*Lasiurus borealis*), and the silver-haired bat (*L. noctivagans*) were detected during the sampling period.
j) The migratory tree bats that could be acoustically isolated (hoary bat and red bat) represented 14.2% of the total bat activity; 57.7% of this activity was detected at the MID microphone.

k) The fact that there was virtually no bat activity during the last two weeks of monitoring (30 September October-12 October) suggests that the sampling protocol captured the vast majority of fall migratory bat activity at the project site.
l) Bat activity at the MWCC project site generally peaked in late July and again in late August. The first peak may represent increased foraging activity at the project site and the volancy of juveniles from nearby summer colonies. The late August peak may represent the beginning of fall migratory activity, but most of this activity was at the LOW microphone.
m) Most of the bat activity at the project site peaked early in the evening and declined steadily throughout the night. This is typical of acoustic sampling of summer activity and therefore probably does not represent migratory activity across the project site.

4.0 ACOUSTIC BAT MIGRATORY DATA CONCLUSION

The utility of conducting pre-construction studies of potential bat use at wind project sites has historically been limited due to the lack of appropriate technology; in particular the inability to monitor bat activity within the rotor sweep zone of the turbine. When acoustic monitors are deployed at ground level, there is an inability to detect a correlation between activity levels and mortality (Erickson et al., 2002) because the monitors do not sample at rotor height. The protocol used in the current study has resolved this issue, but there are not enough studies currently available to determine whether pre-construction activity surveys are predictive of post-construction bat mortality. However, the requirement of fixed elevated monitoring stations limits the ability to sample across the project site. One limitation of the current study is the inability to reliably identify species within the genus *Myotis*. This inability is well documented throughout the range of this genus (Ahlén, 2004; Jones et al., 2004), and therefore does not represent a limitation of the current protocol *per se*. The inability to distinguish within the genus *Myotis* does, however, limits our ability to use these data to quantitatively predict risk for threatened and endangered species.

The timing of the present migratory study is consistent with other pre-construction wind farm projects (Erickson et al., 2002; Reynolds, 2006; 2007a; 2007b; 2008a); therefore these data most likely present an accurate picture of migratory activity within the project area. These data suggest a general level of bat activity (within the detection range of the equipment) in the range of 5.3 calls per detector per night. These data are similar to acoustic data collected at other wind development sites in Pennsylvania (2.9: Reynolds, 2007b; 7.2: Reynolds, 2008a;), Virginia (2.7: NEES, 2006), Wyoming (2.6: Young et al., 2003) and Minnesota (2.2: EPRI, 2003), and lower than data collected from other sites in Pennsylvania (16.4: Reynolds, 2007b) and New York (34.4: Reynolds, 2009).

Bat activity during both the summer sampling period (05 June – 15 August) had an average of 7.2 bats/dn, compared to the fall sampling period (16 August – 12 October) activity level of 7.1 bats/dn. Although this could be interpreted as evidence of fall migratory activity at the project site, it may also represent late seasonal activity of the big brown bat, a species that likely remains active in the area well into the fall because it hibernates locally in buildings surrounding the project site. Overall, these data confirm that the MWCC project site is used predominantly by bats that are known to be abundant in Worcester County. Although the project may result in mortality of residential bats, data from projects throughout North America strongly suggest that these species are killed in low numbers.

A reduction in bat activity with sampling altitude is commonly observed using acoustic monitoring (Reynolds, 2004a; 2004b; 2005; 2006; 2007a; Arnett et al., 2006; 2007; NEES, 2006). The MWCC represents the most extreme decline in bat activity documented to date by NEES, with the LOW microphone representing 80.2% of all the bat activity, followed by the MID microphone (19.7%) and the HIGH microphone (0.05%). The MWCC site is consistent with other pre-construction monitoring surveys in that more migratory tree bat activity was heard at the higher microphone (in this case, the MID microphone) relative to ground-based microphone.

During the present study, we found that the nightly peak in bat activity occurred in the early evening (approximately 20:00) and declined steadily throughout the evening. This is inconsistent with many other pre-construction acoustic monitoring surveys that document bat activity throughout the evening (Reynolds, 2004a; 2005; 2007a; 2007b; 2008a; 2008b). The data from MWCC are more consistent with summer foraging and commuting activity than with sustained migratory activity throughout the evening.

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APPENDIX ONE.

Acoustic Monitoring Protocol

Fixed Platform Monitoring

Prepared by:

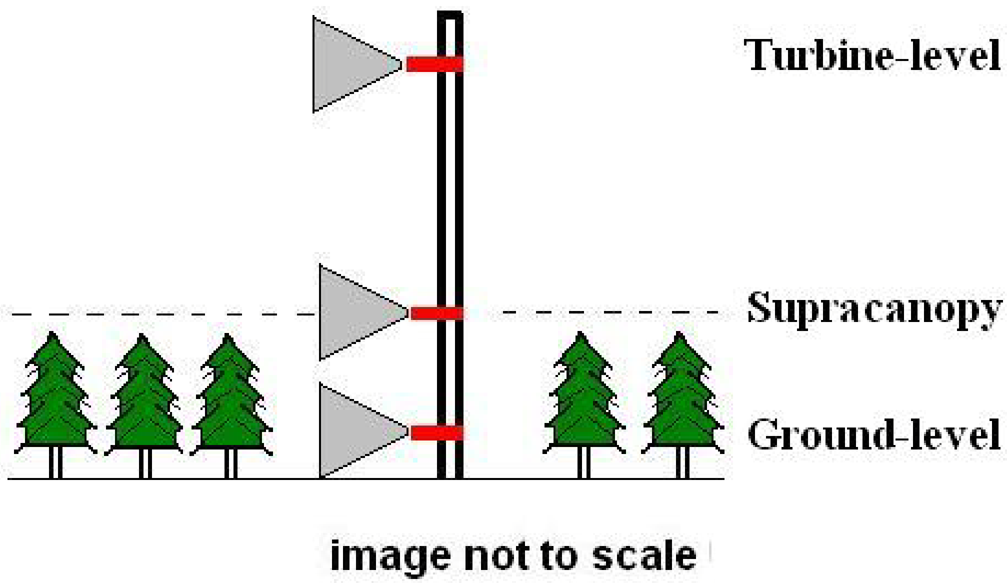
North East Ecological Services (‘NEES’)
52 Grandview Road
Bow, NH 03304
(603) 228-9308

October, 2007

Information contained in this proposal is proprietary in nature and several components currently have patent requests pending. Unauthorized distribution of this proposal to parties not identified above in not permitted without the written permission of NEES.

Acoustic Monitoring
Fixed Platform Protocol

The bat detectors are programmed to operate overnight (1800 – 0800) for fourteen hours. Data will be collected at multiple locations across the Project site using pre-existing meteorological tower. Met towers create an ideal sampling platform for the microphones for three reasons. First, they are typically at least 50m in height and therefore allow us to sample within the proposed rotor sweep zone. Second, met towers are located within the proposed project area, thereby allowing us to sample for bat activity at the Project site. Lastly, met towers have trails and service roads leading to them, and these trails and the edge habitat created by the clearing will provide ideal travel corridors to monitor ground-level bat activity.



Three acoustic monitors (Anabat II or SD-1 ultrasonic detectors: Titley Electronics) will be set up on each Met tower as shown above. Each microphone samples the air space at ground level (roughly 10m above ground), supracanopy level (about 30m above ground), and turbine level (49m above ground). Each microphone is capable of detecting the echolocation calls of approaching bats up to 20m away with a potential sampling volume of $254m^3$ (Larson & Hayes, 2000). The met tower will hold the ultrasonic microphones at altitude, while a shielded cable will transmit data from the microphone to the detector housing stored in a NEMA Type 4 weatherproof box placed on the tower near ground level. Each detector will process and store data on-site using 512MB CF flash cards (this will allow us to store approximately 14,000 individual bat passes). The detectors will be connected to a 12 volt power supply maintained by a 34W photovoltaic charging system.

Each acoustic call heard will be recorded by the monitoring equipment and stored for subsequent analysis. The following data will be collected and recorded for each acoustic call:

Date – Month/Day/Year

Time – Hour/Minute/Second

Height – the detector height that recorded the call (turbine, canopy, or ground)

Species – The species or species group identified through call analysis

Researcher – person conducting the acoustic analysis

For each night of observation, the following information will be collected:

Number – Number of individual calls heard

For each migratory season, the following analysis will be conducted:

Activity Level: the average activity level (in calls/night)

Peak Migratory Activity: the seven-day period of peak migratory activity

Biodiversity Index: the total number of species detected, including indices of species richness and evenness.

Spatial Distribution: the percent of activity detected at each height.

APPENDIX 2: Equipment Calibration Records (1 of 2)

Project Name: Mt Wachusett

Site Name:

Monitoring Season: SUMMER/FALL 2008

Project Start Date: —

Acutal Start Date: 6/05/08

Project End Date: —

Actual End Date: 11/12/08

Tower Height: m

Tower Type: (lattice, monopole, other)

Habitat Description:

Contact Name: Fred Unger Heartwood Group / Rob Rizzo MWCC

Phone: 401 861 1650

Access Code:

Other Access Information:

PV Panel:

Box ID:

Key:

Battery:

Mike Mount: square bracket (fixed, square bracket pulley, pole pulley, other)

	Mike Number	Mike Height	Mike Orientation	Cable Number
LOW	NEES 12	10m	0° (N)	56
MID	NEES 10	30m	0° (N)	57
HIGH	NEES 20	60m	0° (N)	58

	Detector (or SD1)	ZCAIM	Sensitivity Setting	Other Comments
LOW	0195	0157	7	
MID	0112	0201	7 → 6	
HIGH	0196	0138	7 → 5	

Other Installation Comments:

APPENDIX 2: Equipment Calibration Records (2 of 2)

Microphone Calibration - Initiation

Mike ID	Status (G/B)	20 kHz	30 kHz	40 kHz	50 kHz	60 kHz	70 kHz	Angle Test
NCCS 12	G	70	64	56	<50	56	65	3/4
NCCS 10	G	70	64	56	<50	<50	59	OK
NCCS 20	G	68	64	56	<50	<50	59	OK

Sensitivity Settings: 30 kHz
Angle Settings: 30 kHz
Sound Level: 75 dB
Distance: 9 m
Sensitivity: 7

Microphone Calibration - Termination

Mike ID	Status (G/B)	20 kHz	30 kHz	40 kHz	50 kHz	60 kHz	70 kHz	Angle Test
NCCS 12	G	75	59	56	<50	56	62	
NCCS 10	G	84	71	59	<50	<50	64	
NCCS 20	G	77	64	56	<50	<50	62	

Sensitivity Settings: 30 kHz
Angle Settings: kHz
Sound Level: 75 dB
Distance: 9 m
Sensitivity: 7

Detector Calibration - Initiation

Detector ID	Firmware	Start Time	Calibration Date	End Time	Calibration Date
0157	v 4019g			+3,481	12 2008
0201	v 4019g			+3,611	12 2008
0138	v 4019g			+3,656	12 2008